MULTIMEDIA UNIVERSITY

STUDENT ID NO

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MULTIMEDIA UNIVERSITY

FINAL EXAMINATION

TRIMESTER 2, 2017/2018

EOP 3056 – OPTICAL METROLOGY AND TESTING

(OPE)

5th-March- 2018
2.30 P.M – 4.30 P.M
(2 Hours)

INSTRUCTIONS TO STUDENTS

1. This Question paper consists of 6 pages with 4 Questions only.
2. Attempt **ALL** questions. All questions carry equal marks and the distribution of the marks for each question is given.
3. Please print all your answers in the Answer Booklet provided.

Question 1

a. Show that the diameter D_n of the nth Newton's ring when two surfaces of radii R_1 and R_2 are placed in contact , is given by the relation

$$\frac{1}{R_1} \pm \frac{1}{R_2} = \frac{4n\lambda}{D_n^2}$$

[10 marks]

b. Newton's rings are produced by means of a plate and a lens of radius of curvature 5 meters and diameter 2.0 cm.How many rings are observed ? How many rings would be observed if the arrangement were immersed in water $(\mu = 1.33)$? Given $\lambda = 5890 \overset{0}{\text{A}}$.

[6 marks]

c. Using a diagram, explain how a Twyman-Green interferometer can be used to measure the vibration of a moving object .

[9 marks]

Continued .....

Question 2

a. List two advantages of using the Michelson Interferometer for measurement of surface deformation of materials.

[2 marks]

b. A Michelson Interferometer is being used to measure angle displacement as shown in Figure-1

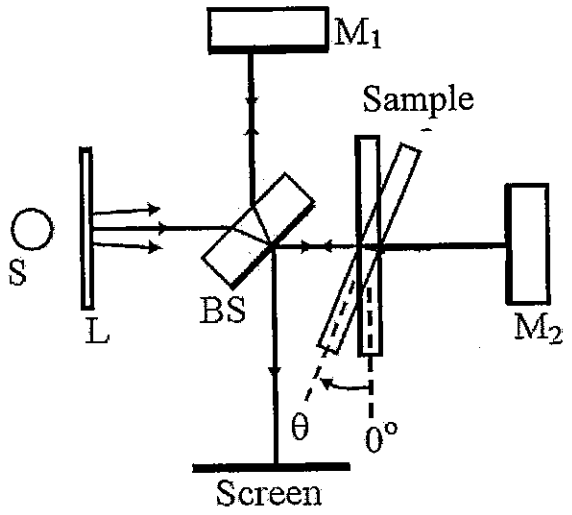

Figure -1

If the sample is turned from position 0° to θ, N number of fringes will shift. Explain, how the angle turned can be related to the fringe shifting.

[9 marks]

c. A cell C of 5 cm length with transparent thin windows is introduced as shown in Figure-2 in one arm of a Michelson's interferometer.Circular fringes are observed with light of $\lambda = 5.46\times10^{-7}$ m.As the pressure of air in the cell is reduced from 760 mm to 380mm 20 fringes disappear.Calculate the refractive index of air at 760 mm pressure.By how much and in what direction should the mirror M_1 be moved to make 20 fringes emerge in the field of view ?

[6 marks]

Continued .....

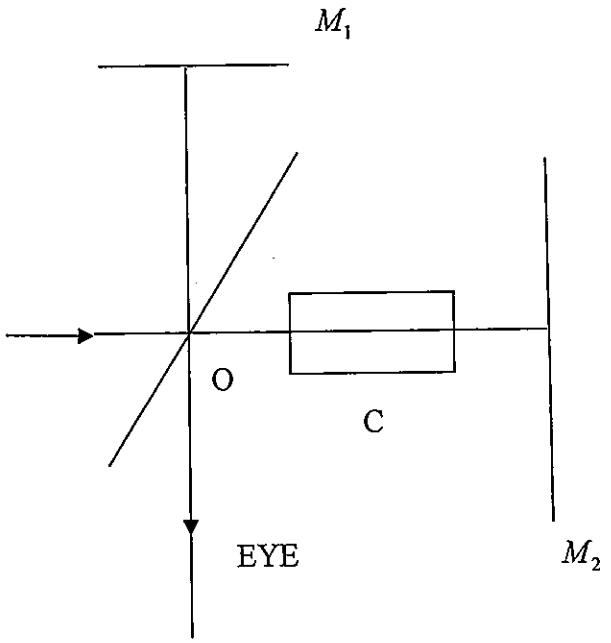

Figure-2

d. The intensity distribution in Fabry-Perot interferometer is given by

$$I_\delta = I_{max} \times \frac{1}{1 + F \sin^2\left(\frac{\delta}{2}\right)}$$

Where F is the coefficient of sharpness.On a diagram show a plot of $\frac{I_\lambda}{I_{max}}$ against δ for the cases (i) F = 20 (ii) F = 5.In the same figure show also the intensity distribution for Michelson interferometer fringes.

[8 marks]

Continued .....

Question 3

a. Foucault test uses the knife-edge (KE) test as an alternative for accurately f optical measuring surfaces.

(i) Consider a KE test on a spherical mirror. Sketch diagrams that best describe the images observed when the KE is moved along the optical axis, pass the center of curvature.

[4 marks]

(ii) Explain what one should observe when the KE is moved sideways, cutting pass the optical axis.

[3 marks]

(iii) Consider a KE test on a parabolic mirror. Using a diagram, explain how the KE test can be used to evaluate parameters of the parabolic mirror.

[6 marks]

b. Consider an engineer in the process of designing a distance measurement system using optical methods. How would the engineer compare Interferometry and Pulse Time-of-Flight methods in terms of:

(i) Range of distance that can be measured [4 marks]

(ii) Accuracy [4 marks]

(iii) Resolution [4 marks]

Continued .....

Question 4

a. Holograms have been shown useful for optical metrology.

(i) Briefly explain the difference between photography and holography [3 marks]

(ii) Describe the process of recording a hologram [3 marks]

(iii) Describe the process of reading a hologram [3 marks]

(iv) Explain briefly how holographic interferometry can be used to make measurements [3 marks]

b. You have been assigned to setup a Fabry-Perot interferometer for measuring wavelength. The wavelength range is 1000 nm – 2500 nm.

(i) Using a diagram, illustrate and explain principles of the Fabry-Perot interferometer for this measurement. [6 marks]

(ii) Explain the procedure for the measurement. [4 marks]

(iii) State the assumptions in making the measurement. [2 marks]

(iv) State a limitation of this method. [1 mark]

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